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ON THE OCCURRENCE OF STARCH IN GREEN FRUITS.

E. H. S. BAILEY and W. S. LONG.

IT IS well to remember at the outset that the chief source of the vegetable food of man is the seeds, seed receptacles, and roots of plants. In making arrangements to reproduce its kind, roots, tubers, seeds, fruits and vegetables each has its own way of attaining the desired result. In tubers, like the potato, there is a great storehouse of starch and other nutrients, and on this the young plant lives until it finds suitable soil in which to grow and continue an independent existence. Grains consist of a storehouse for starch and other nutrients to start the young plant. Some roots, as the beet, containing starch and sugar, have been cultivated for their sugar content, and very much improved in this particular. Fruits, as they ripen, change in composition; the starch is changed to sugar, the harsh tannic acid is replaced by sugar, and the fruit acid—malic, citric, or tartaric—is often much diminished in quantity. These changes are well shown in the analysis of Baldwin apples as published by the Pennsylvania department of agriculture:

	Very green.	Green.	Ripe.	Overripe.
Invert sugar	6.40	6.46	7.70	8.81
Sucrose	1.63	4.05	6.81	5.26
Total sugar by addition	8.03	10.51	14.51	14.07
Starch	4.14	3.67	0.17	.....

The free malic acid in the "very green" apples was 1.14 percent, and in the overripe apples only 0.48 percent.

Some interesting experiments on the persimmon were made by the Bureau of Chemistry of the Department of Agriculture. The astringent taste of the green persimmon is due to the presence of tannic acid, which in the process of ripening is probably changed to sugar. It was learned that the Japanese ripen persimmons artificially by putting them into an empty "Saki" cask, from which the beer has been recently removed. A few lumps of dry starch are also placed in the cask. A study of this process revealed the fact that the ripening was due to the carbon dioxide which remained in the cask, and the starch removed the excess of moisture. So this fruit can now be and is successfully ripened in an atmosphere of carbon dioxide.

We do not expect to find starch in ripe fruits. Even the banana, which when picked green contains about 14 percent of starch, when ripened by modern methods of storage contains only .71 of 1 percent of starch. The green banana is used as a starch-producing food, and the banana flour made from it is utilized by cooking in cakes, gruel and similar products. One reason, although perhaps not the only one, why bananas are by some considered unwholesome is because they are eaten raw, when they are not sufficiently ripened—when they still contain starch. We do not consider raw starch a wholesome food; except in small quantities, it is not as readily digested as when cooked. The yellow banana, when ripe, is usually mottled with black and yellow spots. The odor of the unripe banana is also radically different from that of the ripe fruit.

It might be urged that nuts contain considerable starch, and that we eat them without cooking. It should be noted, however, that those nuts that contain the most starch happen to be the ones most frequently cooked before serving. Acorns are not generally eaten by civilized people; chestnuts, when actually used as food, as in Italy, are usually cooked; and peanuts are roasted before they are edible.

In studying the composition and source of some of the commercial fruit jellies on the market, we observed that some special samples contained what seemed too much starch, so much in fact as to suggest that starch might have been added as a thickener. On further investigation, however, it was learned that while some jellies are made directly from apple juice as a base, later in the season, when apple juice was not available, apple trimmings were used. These apple trimmings are a by-product from the fruit evaporators, and consist of dried skins and cores. These, when examined separately, contain from four to five percent of starch.

There are but few references in literature to starch in fruits. One author states that starch was found in preserves made from bruised apples.[1] The chemical composition of American Food Products,[2] although giving the composition of various food products, makes no mention of the occurrence of starch in any fruits, probably because the ripe fruits only were considered.

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[1] Worcallier, Cause of Abnormal Quantities of Starch in Bruised Apples, Jour. Soc. Chem. Ind., vol. 24, p. 981.

[2] U. S. Dept. of Agric. Bul. 38.

The Pennsylvania department of agriculture,[3] under the title, "A Chemical Study of the Apple and Its Products," gives the following in reference to starch in apples:

Very green apples	4.14%
Green apples	3.67
Ripe	0.17
Overripe apples	....

It would hardly be supposed that green apples would be used for making evaporated or dried apples. One sample of jelly labeled as made from corn sirup and apple, which was in reality made from corn sirup and apple trimmings, contained .7 of 1 percent of starch. As this jelly contained 34 percent of water, the starch paste was about a 2 percent solution. This preparation of dry starch goes quite a way towards thickening a product. It is not assumed, however, that the manufacturer of a fruit jelly desires to have starch as one of the constituents of his product, for starch ferments readily, and would tend to make the product spoil more quickly. The starch is, of course, a cooked starch in the finished product, so it would not be easy to tell what its source was, whether from the fruit used or from some other source. It seems, therefore, that it will be necessary to allow these commercial jellies to come on the market, even if they do contain small quantities of starch. In case they are made from apple trimmings the fact should be stated on the label. We shall, at the proper season, test some green fruits to learn something more definite as to their starch content.

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[3] Bulletin Penn. Dept. Agr. 38.